

National Airspace System

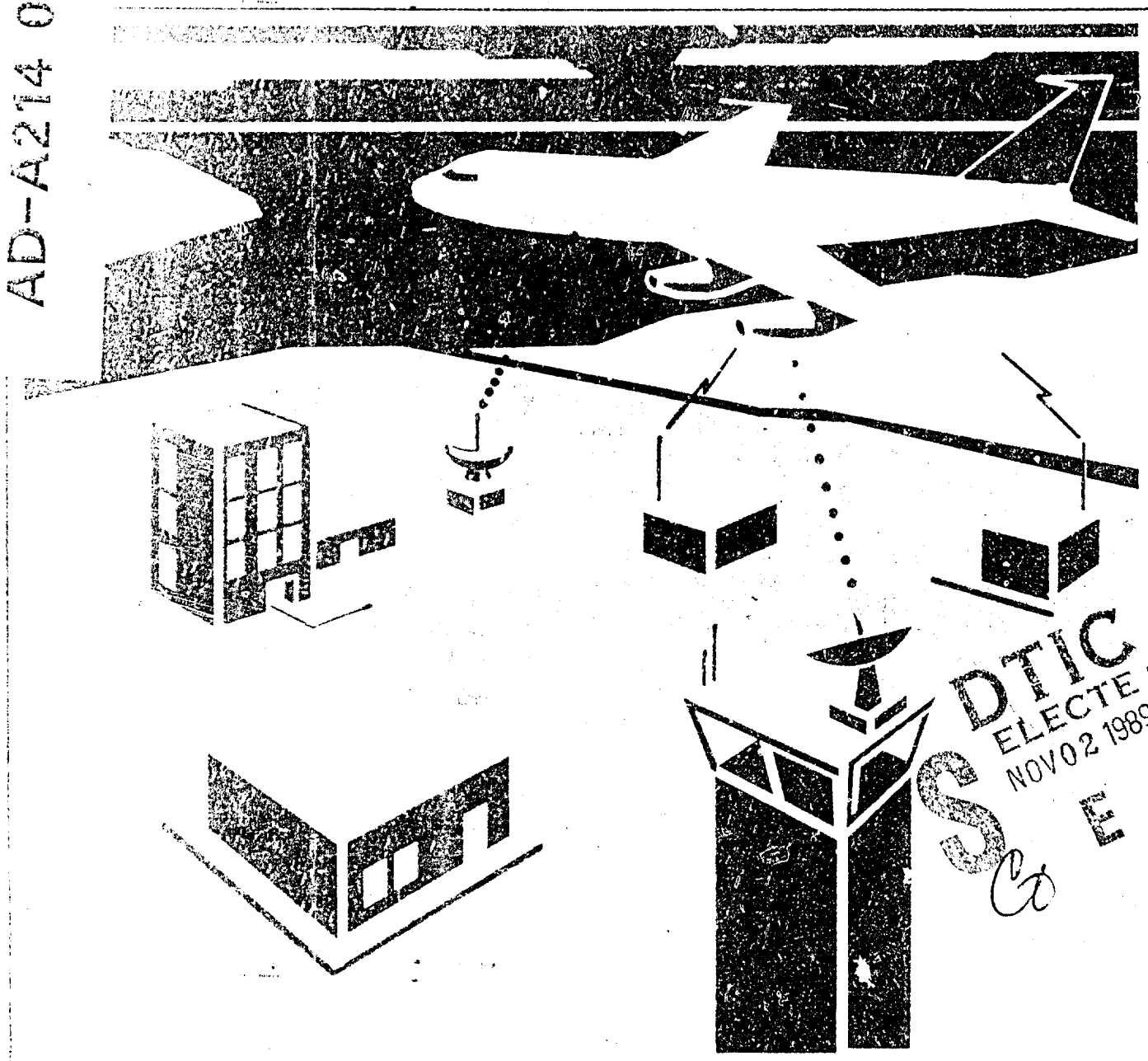
Ground and Obstacle
Avoidance Operational
Concept
NAS-SR-1323



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National Airspace System Ground and Obstacle Avoidance Operational Concept (NAS-SR-1327)

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Federal Aviation Administration
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16. Abstract → A requirement for the National Airspace System (NAS) is to provide for detecting the need for and assisting in ground and obstacle avoidance activities, as identified in the NAS System Requirement Specification, NAS-SR-1000. This document presents a concept of operations for ground and obstacle avoidance. It describes ground and obstacle avoidance assistance capabilities and shows the relationships between subsystems, facilities, information, and operators/users. It is intended to provide a common perspective for personnel involved in ground and obstacle avoidance activities, assist in determining whether the ground and obstacle avoidance activities meet formal requirements, and support coordination among the organizations involved. <i>Keywords:</i>			
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TABLE OF CONTENTS

	<u>Page</u>
LIST OF FIGURES	iii
LIST OF TABLES	iii
1.0 INTRODUCTION	1-1
1.1 Background	1-1
1.2 Objective	1-1
1.3 Scope	1-1
1.4 Methodology	1-2
1.5 Document Organization	1-4
2.0 GROUND AND OBSTACLE AVOIDANCE OPERATIONS	2-1
2.1 Support	2-1
2.2 Information	2-4
2.2.1 Information Generated from Flight Data	2-5
2.2.2 Information from the Flight Plan	2-5
2.2.3 Information from the NAS	2-6
2.3 Functions	2-6
2.3.1 Approach/Departure Controller (Position 6) and En Route Controller (Position 7)	2-6
2.3.2 Local Controller (Position 9)	2-9
2.3.3 Clearance Delivery Controller (Position 11)	2-12
2.4 Correlation with Operational Requirements	2-14
2.5 Operational Sequences	2-14
2.5.1 Terminal Operational Sequence	2-14
2.5.2 Tower Operational Sequence	2-17

TABLE OF CONTENTS (CONTINUED)

2.6 Operational Scenario	2-20
2.6.1 VFR Operational Scenario	2-20
2.6.2 IFR Operational Scenario	2-20
2.6.3 Tower Operational Scenario	2-23
REFERENCES	RE-1
ACRONYMS/ABBREVIATIONS	AA-1
GLOSSARY	GL-1

LIST OF FIGURES

<u>Figure Number</u>		<u>Page</u>
2-1	OVERVIEW OF NAS/USER INTERFACES FOR GROUND AND OBSTACLE AVOIDANCE	2-2
2-2	GROUND AND OBSTACLE AVOIDANCE BLOCK DIAGRAM	2-3
2-3	APPROACH/DEPARTURE CONTROLLER OPERATIONAL AND EN ROUTE FLOW DIAGRAM	2-8
2-4	LOCAL CONTROLLER OPERATIONAL FLOW DIAGRAM	2-11
2-5	CLEARANCE DELIVERY CONTROLLER OPERATION FLOW DIAGRAM	2-13
2-6	APPROACH/DEPARTURE CONTROLLER AND EN ROUTE SEQUENCE DIAGRAM	2-16
2-7	LOCAL CONTROLLER OPERATIONAL SEQUENCE DIAGRAM	2-18
2-8	CLEARANCE DELIVERY OPERATIONAL SEQUENCE DIAGRAM	2-19
2-9	VFR GROUND AND OBSTACLE AVOIDANCE SCENARIO	2-21
2-10	IFR GROUND AND OBSTACLE AVOIDANCE SCENARIO	2-22
2-11	TOWER GROUND AND OBSTACLE AVOIDANCE SCENARIO	2-24

LIST OF TABLES

<u>Table Number</u>		
2-1	GROUND AND OBSTACLE AVOIDANCE OPERATIONAL REQUIREMENTS CORRELATION	2-15

1.0 INTRODUCTION

1.1 Background

The responsibility for maintaining an appropriate distance for ground and obstacle avoidance ultimately rests with the pilot; however, the National Airspace System (NAS) is required to provide assistance. The National Airspace System System Requirements Specification (NASSRS), NAS-SR-1000, describes the requirements to provide ground and obstacle avoidance assistance to pilots.

This operational concept document has been developed using an established standard format and is consistent in structure with a series of operational concepts which address various sections of the NASSRS.

1.2 Objective

The objective of the ground and obstacle avoidance operational concept is to describe how ground and obstacle clearance assistance will be provided in the NAS "end state" system. This document is intended for management and technical personnel of the Federal Aviation Administration (FAA), as well as outside organizations, to provide a clear understanding of how ground and obstacle avoidance services are provided to the users. More specifically, the purpose of this document is to:

1. Provide a common operational perspective across subsystems, operators, and users.
2. Show the interrelationships among subsystems, facilities, information, and operators/users.

1.3 Scope

The ground and obstacle avoidance operational concept presented herein describes the services provided as outlined in Section 3.2.7 of the NASSRS. The operations described are limited to those associated solely with ground and obstacle avoidance services. This concept describes services provided by certain types of specialists/controllers. The names assigned to the specialist/controller positions in this document are based on the primary function performed and may not be commonly used today or may change at a later date as the NAS evolves. The functions performed, however, will not change. Additionally, the simplifying constraint of communications transparency has been implemented throughout the development of this operational concept; i.e. communications systems serve only as a "pass through" for information and are therefore not included.

Section 3.6 of the NASSRS describes the requirements for communications and is described in another operational concept.

The specific paragraphs in the NASSRS Section 3.2.7 and their contents are as follows:

3.2.7 General Requirements

- .A Section 3.2.3.A, B, C and J Flight Plan Information
- .B Develop Maintain Obstacle Information
- .C Available Obstacle Information
- .D Predict Potential Obstacle Encounters
- .E Alert Aircraft to Potential Encounters
- .F Actions to Avoid Encounters
- .G Display Recommended Actions
- .H Continuous Avoidance Capabilities

1.4 Methodology

The methodology employed to develop the ground and obstacle avoidance operational concept is similar to the methods and tools used for system development, in that successive levels of decomposition of ground and obstacle avoidance are represented. This document starts with the overall concept and proceeds to its most elemental levels of support, diagrammatic tools, and the techniques that constitute ground and obstacle avoidance support. These analytical tools are:

1. Operational Block Diagram/Description. The operational block diagram illustrates the connectivity between major elements of the NAS, i.e., processors, specialists/controllers, and the user for those elements that support the service. The operational block diagram in this operational concept is extracted from the overall NAS operational block diagram. Principal features of the operational block diagram/description include the following:
 - a. Each specialist/controller is indicated by a number. This number remains the same in every operational concept.
 - b. Dotted lines segregate facilities.
 - c. Solid lines show digital data flow. Voice data flow is not shown.
 - d. The blocks within each facility are the major processors.

2. Operational Flow Diagrams/Descriptions. An operational flow diagram and associated description of each specialist provide details concerning the inputs, processes, outputs, and interfaces for each operator; thus, the operational flow diagram provides an expansion of each element of the NAS as shown in the ground and obstacle avoidance component master block diagram. Operational flow diagrams are used to functionally describe the products and services of individual specialists.
3. Operational Sequence Diagrams/Descriptions. The operational sequence diagram and associated description show a typical sequence of steps taken by operations/users in supporting ground and obstacle avoidance operations. Principal features of an operation sequence diagram include the following:
 - a. Users, specialists, and computer systems providing ground and obstacle avoidance functions are listed along the vertical axis. When required for clarity, other FAA facilities may also be listed on the vertical axis.
 - b. The horizontal axis represents time. Sequential events or functions performed are indicated within separate boxes. Events which may occur simultaneously or near-simultaneously are shown vertically.
 - c. Decision points or points where alternate paths may be followed are indicated by a diamond shape.
 - d. Circles are connectors and indicate exit to, or entry from, another diagram. Circles with a lower case alphabetic character reference an operator function described in the figure listed below the circle. Circles connect either to another sheet of the same diagram or to another diagram; the relevant figure number is listed underneath if connection is made to a different diagram. Thus, the relationship between operator/user interactions and relevant NAS subsystems can be depicted.

1.5 Document Organization

The remainder of this document is organized in the following manner. Section 2 is the main body of the document and is divided into six subsections. Section 2.1 provides an overview description of the ground and obstacle avoidance function and identifies the personnel compliment and physical entities (facilities and computer systems) which provide the required support. Section 2.2 describes the information used to provide ground and obstacle avoidance support. Section 2.3 provides descriptions of the functional decomposition of ground and obstacle avoidance. Section 2.4 describes the correlation of the operational requirements described in the NASSRS and this document. Sections 2.1, 2.2, 2.3, and 2.4 reference related NASSRS 3.2.7 subsystems. Section 2.5 provides a sequence of interactions between system and personnel entities during the planning and the implementation phases of ground and obstacle avoidance operations, and Section 2.6 presents ground and obstacle avoidance operational scenarios.

2.0 OPERATIONS

2.1 Support

Although maintaining appropriate obstacle clearance is ultimately the responsibility of the user, the NAS is required to provide ground and obstacle avoidance assistance to its users. This requirement is described in Section 3.2.7 of the NASSRS. Ground and obstacle avoidance assistance is provided by Approach/Departure and En Route Controllers at an Area Control Facility (ACF), and Local and Clearance Delivery Controllers in Air Traffic Control Towers (ATCT). The NAS provides these services to IFR aircraft and, upon request, to properly equipped VFR aircraft. Ground obstacle avoidance services provided by the NAS is contingent upon users having an operational altitude encoding transponder (Mode C/S) as part of their basic equipment.

Figure 2-1 is an overview of NAS/user interfaces for ground and obstacle avoidance assistance and illustrates the NAS facilities and systems involved.

Figure 2-2 is an operational block diagram showing the interrelationships among equipment, facilities, operators/users, and the information necessary to support ground and obstacle avoidance assistance. The following paragraphs briefly summarize the functions of ground and obstacle avoidance assistance at each position shown in Figure 2-2.

Position 6 and Position 7: Approach/Departure Controller and En Route Controller

Function: Provide ground and obstacle avoidance assistance to aircraft within their area of jurisdiction through their Sector Suites.

Description: Approach/Departure Controllers and En Route Controllers assign altitudes at or above the Minimum Obstruction Clearance Altitudes (MOCA), Minimum En Route Altitudes (MEA) as well as Minimum IFR Altitude (MIA) and Minimum Vectoring Altitude (MVA) for off-airway clearances, to aircraft. Additionally, these controllers operating in designated mountainous terrain areas use altitudes derived from an Emergency Obstruction Video Map (EOVM), when required, during emergency procedures.

Approach/Departure Controllers and En Route Controllers also issue safety advisories to any aircraft that is in unsafe proximity to terrain or obstructions.

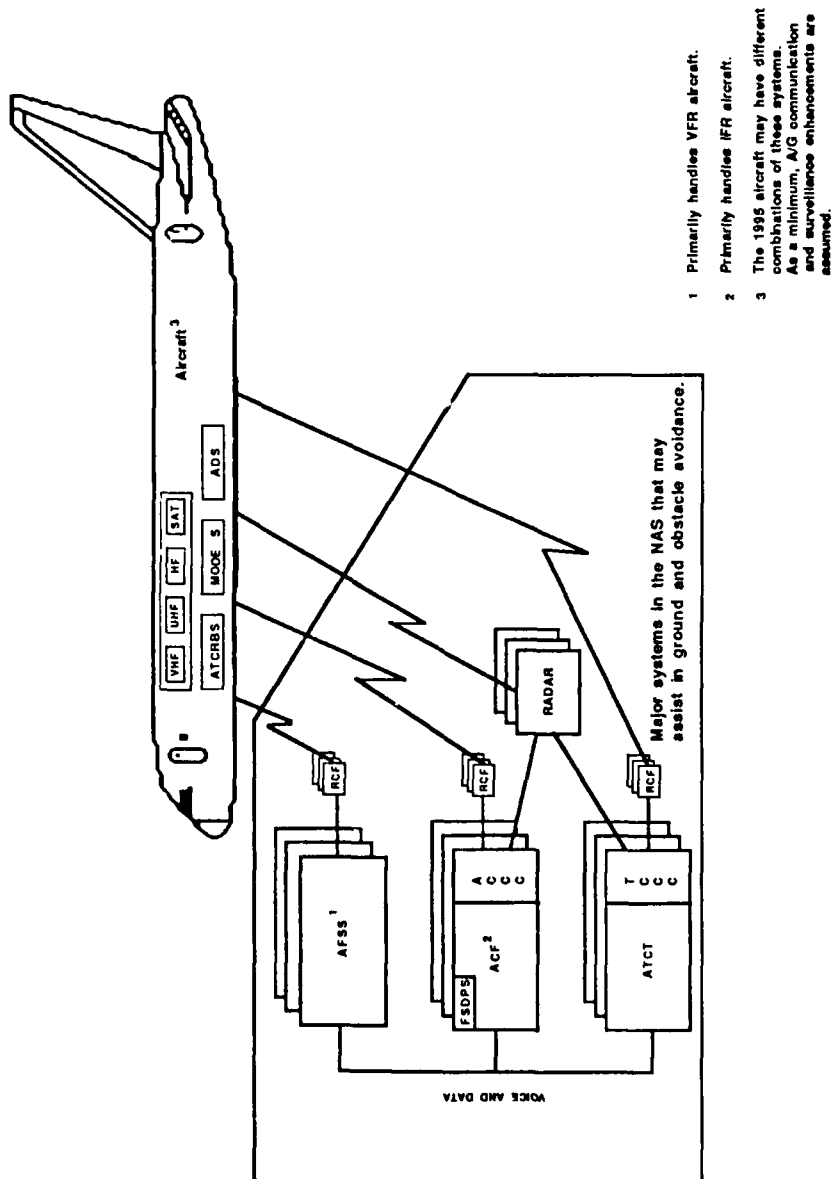


FIGURE 2-1
OVERVIEW OF NAS/USER SYSTEMS FOR
GROUND AND OBSTACLE AVOIDANCE

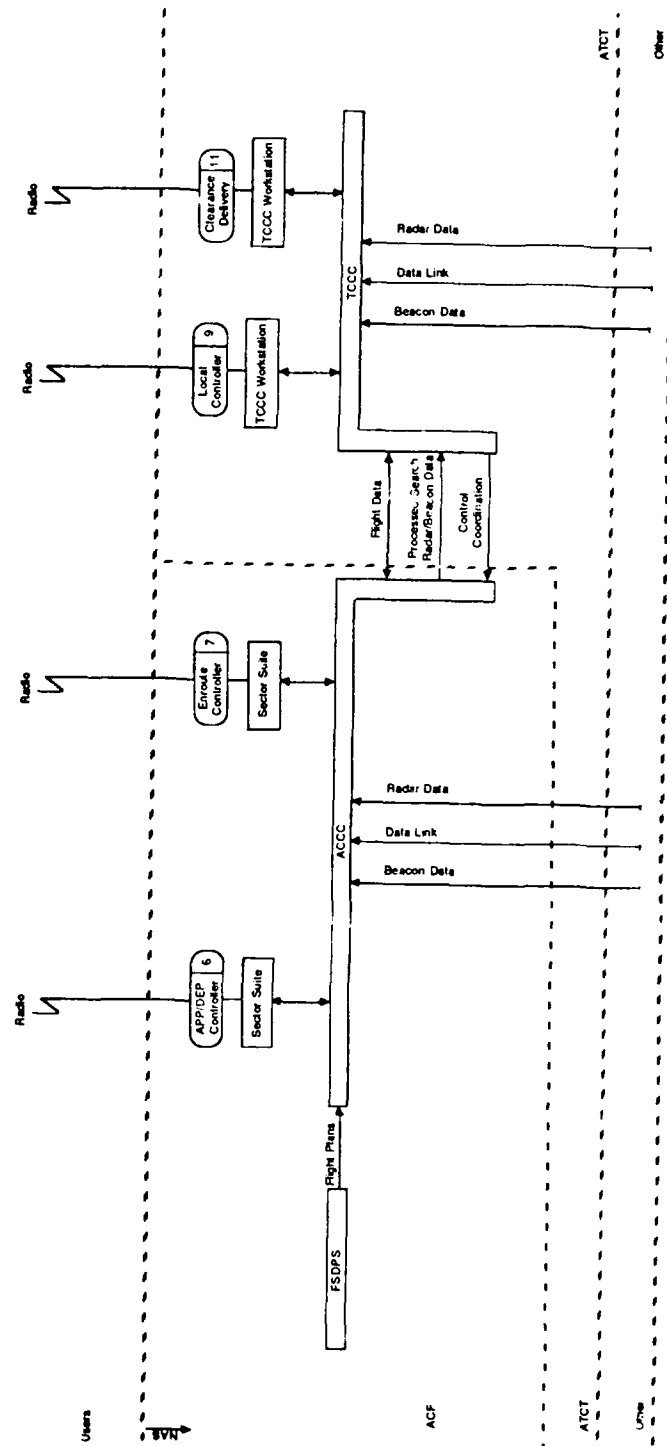


FIGURE 2-2
OPERATIONAL BLOCK DIAGRAM

Procedures: FAA, Air Traffic Control, (7110.65E); Chapter 2, Section 1; Chapter 4, Section 5; Chapter 5, Section 5, Section 8, Section 14, Section 15, Chapter 9, Section 2.

Projects: NAS Plan, Terminal Systems, Project 12: Advanced Automation System, (AAS); Project 13: Automated En Route Air Traffic Control (AERA), Project 15: Area Control Facilities (ACF).

Position 9: Local Controller

Function: Provides ground and obstacle avoidance assistance to aircraft within the airport traffic area.

Description: Local Controllers monitor arrival aircraft and issue safety advisories to participating aircraft that are in unsafe proximity to terrain or obstructions.

Procedures: FAA, Air Traffic Control, (7110.65E); Chapter 2, Section 1; Chapter 4, Section 5.

Projects: NAS Plan, Terminal Systems: Project 13, ATCT/TRACON establishment, replacement, and modernization.

Position 11: Clearance Delivery Controller

Function: Provide altitude verification to departing IFR aircraft as part of the clearance read back to the pilot.

Description: Clearance Delivery Controllers assign altitudes at or above MEA, MOCA, as well as altitude verification to departing aircraft to ensure obstacle clearance.

Procedure: FAA, Air Traffic Control (7110.65E); Chapter 2, Section 1; Chapter 4, Section 5.

Projects: NAS Plan, Terminal Systems: Project 12, ATCT/TRACON establishment, replacement, and modernization.

2.2 Information

The function of ground and obstacle avoidance assistance requires a core of information obtained from a number of sources within the NAS. This information is derived from the filed flight data base within the Flight Service Data Processing System (FSDPS), the Area Control Computer Complex (ACCC), and the Tower Control Computer Complex (TCCC) and provides the initial filed altitude requests to the specialists who can review it for correctness. Additionally, each area within the Approach/Departure and En Route Controllers' airspace has been pre-programmed with minimum safe altitudes. Once a computer-tracked aircraft enters an area below its predetermined safe altitude, the

controller is alerted.

2.2.1 Information Generated from Flight Data

In addition to the information required in Section 3.2.7 of the NASSRS, the following information from Section 3.2.3 establishes the foundation for the flight data information that is presented to the specialists. Accurate and current information on ground, terrain, and known obstacles are depicted on the controllers' Sector Suite display. The controller references this information when providing ground and obstacle avoidance services. After the flight plan information is loaded, the ACCC generates and displays flight information to the controller on his/her Sector Suite. This information depicts the position of the aircraft for the controller's reference. Once a track is started, either automatically by the NAS or manually by the controller, the flight information (data block) is updated by the NAS to provide the flight position of the aircraft and any changes in the aircraft's altitude or speed are detected.

Flight information is acquired and passed to the next area of jurisdiction (controlled airspace) prior to the aircraft entering that area of jurisdiction. This passing of information is accomplished at a specified time or distance from the next specialist's airspace. Flight plan information, drawn from the flight plan data base, is acquired and depicted on the controller's display. This information, including any changes in route, altitude, or speed is used by the controller when providing ground and obstacle avoidance services. The NAS displays the route readout (clearance-based trajectory) on all valid flight plans, including any route changes, to the controller.

The NAS correlates the actual flight plan information with the filed flight plan information and updates the flight plan data base with actual changes. For example, if headwinds slow an aircraft such that it no longer is proceeding at its filed airspeed, the NAS recalculates the aircraft's airspeed and updates the data base accordingly. This will allow a more accurate determination of the aircraft's position at any time.

The NAS also assists the specialist with his/her assigned route and, in the event the aircraft must leave its intended route of flight (safety advisory), the NAS recommends the correct action to return the aircraft to its original route of flight.

2.2.2 Information from the Flight Plan

The active flight plan of an aircraft is used to provide ground and obstacle avoidance assistance by providing identification, current and projected location (position), altitude, speed, and track. This

information is used by the controllers and the NAS systems to provide early signs of conflict or to trigger the alarm monitoring process.

2.2.3 Information from the NAS

The NAS provides information to support ground and obstacle avoidance assistance in the form of accurate and current location and elevation on the ground, terrain, and known obstacles throughout the area of NAS responsibility. This information is provided, upon request, to both users and specialists in a visually accurate format.

The NAS provides a system which will alert the specialist via automated functions such as Minimum Safe Altitude Warning (MSAW or E-MSAW for En Route). These functions use the ground, terrain, and known obstacles data resident in the NAS, altitude information from the aircraft's Mode C altitude encoding altimeter, and the flight data for the aircraft to provide ground and obstacle avoidance assistance.

2.3 Functions

The following paragraphs describe in more detail the functional services provided by the specialist/controller positions introduced in Section 2.1. The operational flow diagrams associated with each paragraph illustrate the information flow between the specialist and the user, the specialist and other specialists, and between the specialist and data processing equipment. The functions performed by the NAS are explicitly covered by requirements specified in the NASSRS. The pertinent NASSRS paragraphs that specify the function being performed are referenced in each of the paragraphs that follow.

2.3.1 Approach/Departure Controller (Position 6) and En Route Controller (Position 7)

Since ground obstacle avoidance services provided by Approach/Departure and En Route Controllers are essentially the same they will be combined for this operational concept.

The Approach/Departure Controller and the En Route Controller provide ground and obstacle avoidance assistance to aircraft in terminal and en route areas by issuing MEA, MOCA, MIA, and MVA to aircraft. Additionally, when an aircraft is in unsafe proximity to terrain or obstacles, these controllers are alerted by the use of automated functions such as MSAW. Once alerted, these controllers immediately issue a safety advisory to the endangered aircraft, including the proper aircraft altitude for a specific location.

Figure 2-3 is an operational flow diagram describing the functions and services provided by the Approach/Departure and En Route Controllers in the ACF. Letter blocks which identify the functions performed by these controllers are described in the corresponding paragraphs below.

- a. ACCC processing. The ACCC houses the flight data base that includes both the altitude of the aircraft as well as predetermined minimum safe altitudes (including MEA, MOCA, MIA and MVA) for particular areas. The ACCC is accessed through Sector Suites.

NASSRS requirement 3.2.7.C 1 - 3.

- b. Obtains accurate obstacle information available for monitoring services. Current and complete information on ground, terrain, and known obstacles are available to specialists from the NAS at their working positions in a visual format.

NASSRS requirements 3.2.7.B 1 and 2; 3.2.7.C 1 - 3.

- c. Provides predicted potential encounters. The Approach/Departure and En Route Controllers are notified through their Sector Suites of potential encounters based on current clearance-based trajectories and short-term projections. The NAS provides the capability to evaluate alternate clearance-based trajectories and with respect to potential encounters with the ground, terrain, and obstacles.

NASSRS requirement 3.2.7.D 1 - 3.

- d. Receives Alerts and Alerts the Pilot. The NAS alerts the Approach/Departure and En Route Controllers, within 75 seconds of the predicted time of encounter, both aurally and visually, through the MSAW. The Approach/Departure or En Route Controller relays this alert to the user within 65 seconds via voice and/or air-ground data communications.

NASSRS requirement 3.2.7.E 1 - 3.

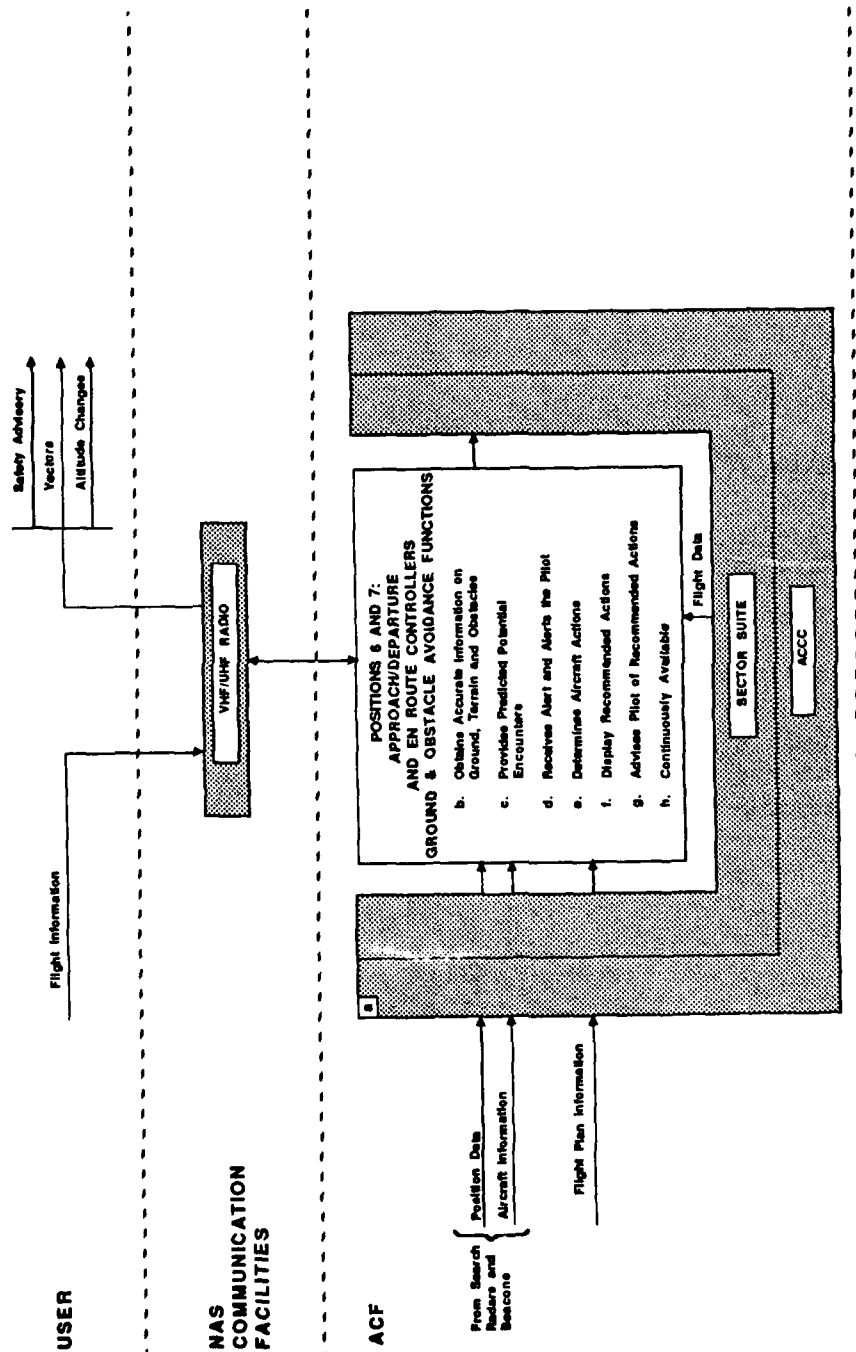


FIGURE 2-3
OPERATIONAL FLOW DIAGRAM, POSITION 6 AND 7:
APPROACH/DEPARTURE AND EN ROUTE CONTROLLERS
PROVIDING GROUND & OBSTACLE AVOIDANCE ASSISTANCE

- e. Determines aircraft actions. Once notified of a potential encounter with the ground or with an obstacle, the ACCC alerts the controller to the conflict and determines the action the aircraft should take to avoid the encounter.

NASSRS requirement 3.2.7.F.

- f. Displays recommended action. Once the recommended action to avoid the ground or obstacle has been determined, the ACCC displays the recommended action or actions to the specialist through their Sector Suite.

NASSRS requirement 3.2.7.G

- g. Advises pilot of recommended actions. ACF controllers advise pilots of recommended or alternative actions in sufficient time to avoid the encounter.

NASSRS requirement 3.2.7.G.

- h. Continuous monitoring. Approach/Departure and En Route Controllers have ground and obstacle avoidance capabilities available to them on a continuous basis. These services are provided to the Controllers and users at all times.

NASSRS requirement 3.2.7.H

2.3.2 Local Controller (Position 9)

Local Controllers provide ground and obstacle avoidance assistance to airborne aircraft within the Airport Traffic Area. This assistance is provided through the use of the Tower Computer Control Complex (TCCC) and Digital Bright Radar Indicator Tower Equipment (DBRITE). When an aircraft is observed in close proximity to the ground, Local Controllers are alerted by the MSAW function within the TCCC and immediately issue a safety advisory to the pilot, including the safe altitude for the aircraft's position.

Figure 2-4 is an operational flow diagram describing the functions and services provided by Local Controllers working in control towers. Letter blocks that identify the functions performed by these controllers are described in the corresponding paragraphs below.

- a. TCCC processing. The TCCC houses the flight data base which includes the aircraft's route of flight and altitude. The TCCC is accessed through TCCC Position Consoles.

NASSRS requirement 3.2.7.D. 1 - 3.

- b. Obtains Accurate obstacle information for monitoring. Current and complete information on ground, terrain, and known obstacles is available to specialists at their working positions in a visual format.

NASSRS requirement 3.2.7.C. 1 - 3.

- c. Provides Predicted potential encounters. The Local Controller is notified of potential encounters with the ground, terrain, or obstacles based on current clearance-based trajectories and short-term projections from the TCCC (through the DBRITE).

NASSRS requirement 3.2.7.D.

- d. Receives Alert and Alerts the Pilot. The TCCC alerts the Local Controller, both aurally and visually, within 40 seconds in advance of the predicted time of the encounter, through the DBRITE. The local controller alerts the pilot at least 30 seconds in advance of the predicted time of the encounter.

NASSRS requirement 3.2.7.E.

- e. Determines aircraft actions. Once alerted of a potential encounter with the ground or an obstacle, the TCCC sends an alert message to the controller via DBRITE of the conflict and determines the action the aircraft should take to avoid the encounter.

NASSRS requirement 3.2.7.F

- f. Advises pilot of recommended actions. Local controllers advise pilots of recommended or alternate actions in sufficient time to avoid the encounter.

NASSRS requirement 3.2.7.G.

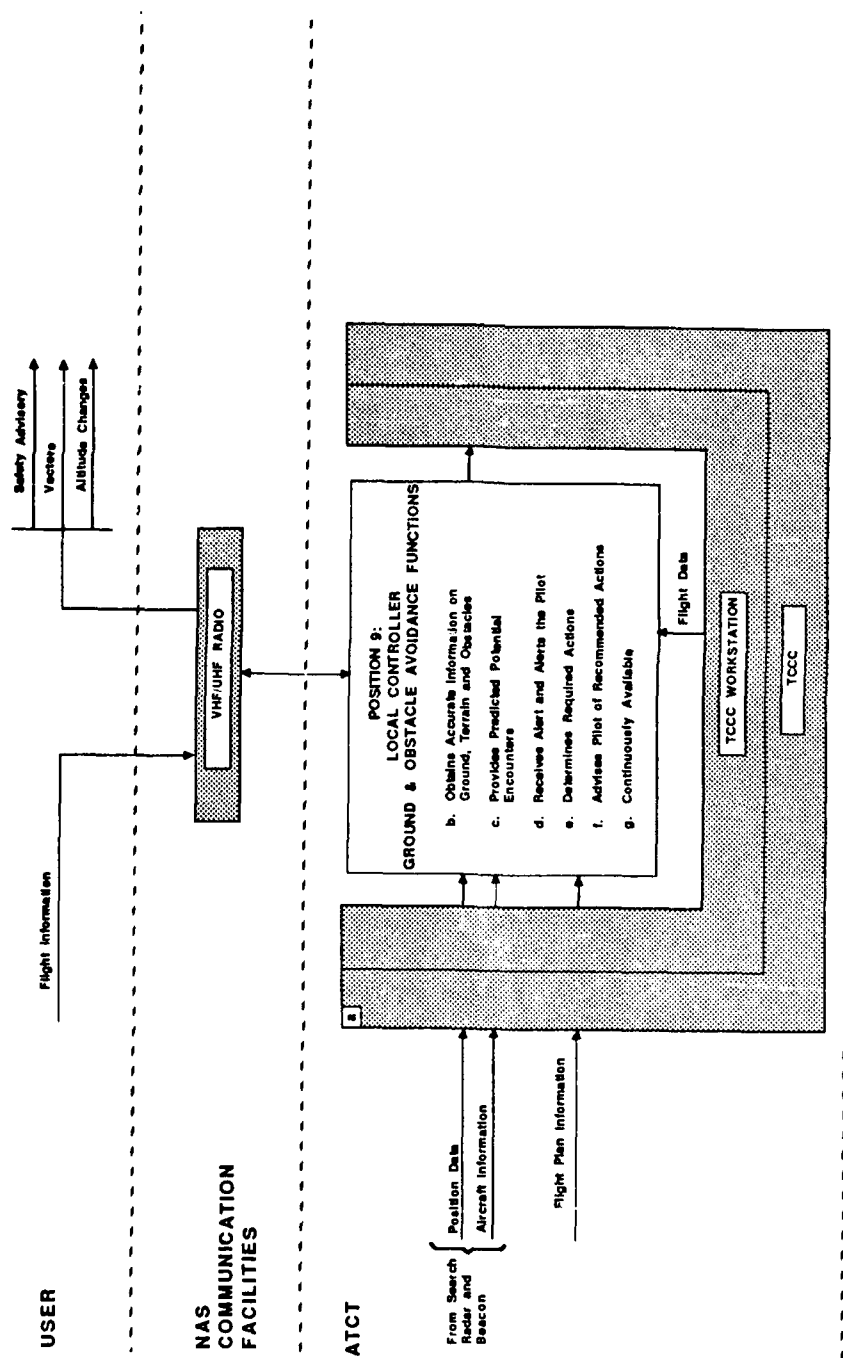


FIGURE 2-4
OPERATIONAL FLOW DIAGRAM, POSITION 9:
LOCAL CONTROLLER
PROVIDING GROUND & OBSTACLE AVOIDANCE ASSISTANCE

- g. Continuous Monitoring. Local Controllers have ground and obstacle avoidance capabilities available to them on a continuous basis.

NASSRS requirement 3.2.7.H.

2.3.3 Clearance Delivery Controller (Position 11)

Clearance Delivery Controllers in the control towers preview flight plans prior to their issuance to pilots to check for the correct altitude for the aircraft's route of flight. The aircraft's proposed altitude for its intended route of flight is checked against the MEA and the MOCA within the Airport Traffic Area to ensure obstacle avoidance.

Figure 2-5 is an operational flow diagram describing the functions and services provided by the Clearance Delivery Controller in the control tower. Letter blocks that identify the functions performed by these controllers are described in the corresponding paragraphs below.

- a. TCCC processing. The TCCC houses the flight data base that includes both the altitude of the proposed aircraft and its intended route of flight. The TCCC is accessed through the TCCC Position Consoles.

NASSRS requirement 3.2.7.D.

- b. Obtains Available obstacle information for monitoring. Clearance Delivery Controllers maintain accurate, complete, and current aeronautical information for their particular area of responsibility. This information is used in ensuring the correct obstacle clearance or minimum en route altitude. This information is posted adjacent to the specialists' positions.

NASSRS requirement 3.2.7.C. 1 - 3.

- c. Provides Predicted potential encounters. Prior to issuing the clearance, the Clearance Delivery Controller predicts potential encounters with the ground, terrain, or obstacles after reviewing a flight plan. This controller ensures the requested assigned altitude for a route of flight will have the MOCA and MEA within the control towers' area of jurisdiction.

NASSRS requirement 3.2.7.D 1 - 3.

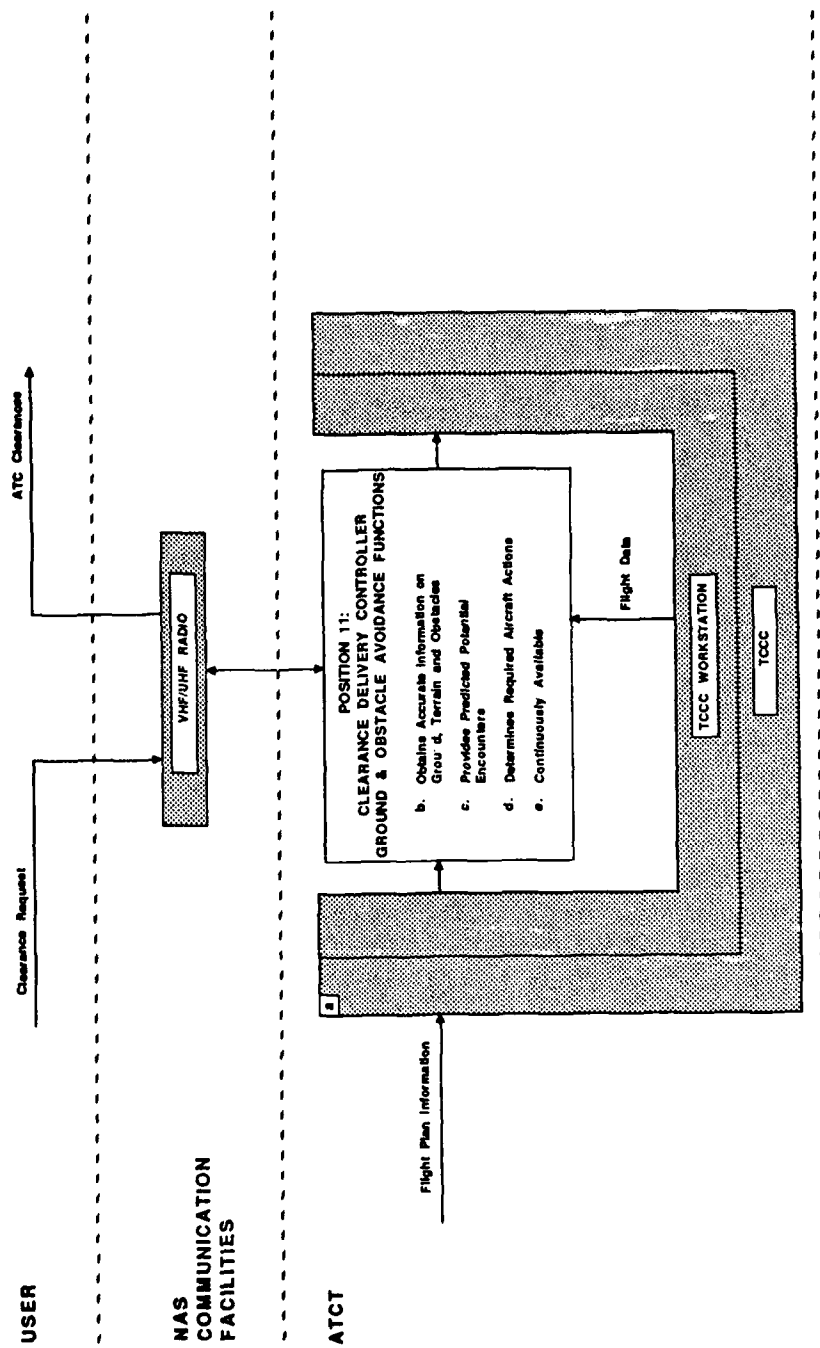


FIGURE 2-5
OPERATIONAL FLOW DIAGRAM, POSITION 11:
CLEARANCE DELIVERY CONTROLLER
PROVIDING GROUND & OBSTACLE AVOIDANCE ASSISTANCE

- d. Determines aircraft actions. The Clearance Delivery Controller, after reviewing a proposed route of flight and altitude request, determines the correct altitude for the route of flight and relays this information to the pilot as part of the clearance procedures.

NASSRS requirement 3.2.7.F.

- e. Continuous Monitoring. Clearance Delivery Controllers continuously review proposed clearances for obstacle avoidance within their assigned airspace.

NASSRS requirement 3.2.7.H.

2.4 Correlation with Operational Requirements

Table 2-1 summarizes the correlation of the ground and obstacle avoidance requirements paragraphs of NAS-SR-1000 with the paragraphs describing the functions being performed by specialists/controllers. All ground and obstacle avoidance paragraph numbers of NAS-SR-1000 are listed; paragraphs which are introductory in nature and do not state an explicit operational requirement or reference other portions of NAS-SR-1000 are indicated with a dash. The fact that a correlation is shown between a requirements paragraph and a paragraph describing the specialist/controller functions performed should not be construed as indicating that the requirement is completely fulfilled.

2.5 Operational Sequence

Operational sequence diagrams have been developed to illustrate the interactions between users (pilots) and specialists/controllers for different categories/conditions of flight. These diagrams are general in nature and no effort has been made to depict a specific situation.

2.5.1 Terminal Operational Sequence

ACF Controllers assigned to provide coverage for the terminal areas around airports have the capability to provide ground and obstacle avoidance assistance to pilots. This assistance is provided to arriving, departing, and overflight traffic within the terminal and en route areas. Figure 2-6 illustrates a general sequence of operator/user interactions for ground and obstacle avoidance assistance provided by Approach/Departure and En Route Controllers working in the ACF.

TABLE 2-1
GROUND & OBSTACLE AVOIDANCE
OPERATIONAL REQUIREMENTS CORRELATION

	APPROACH/DEPARTURE AND EN ROUTE CONTROLLER							LOCAL CONTROLLER							CLEARANCE DELIVERY CONTROLLER				
NAS-SR-1000 PARAGRAPH	2.3.1a	2.3.1b	2.3.1c	2.3.1d	2.3.1e	2.3.1f	2.3.1h	2.3.2a	2.3.2b	2.3.2c	2.3.2d	2.3.2e	2.3.2f	2.3.2g	2.3.3a	2.3.3b	2.3.3c	2.3.3d	2.3.3e
3.2.7 General	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3.2.7 A Paragraph 3.2.3 Req's	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B Complete Obs. Information	--	X																	
B1 Ground & Terrain	X															X			
B2 Man-Made Obs.	X															X			
C Avail/Accurate Data	X	X							X										
C1 Info. Upon Request	X	X							X							X			
C2 Info. For Specific Areas	X	X							X							X			
C3 Info. In Visual Format	X	X							X							X			
D Detect Gnd. Encounters			X					X		X							X		
D1 Predict Gnd. Encounters			X					X									X		
D2 Projected Encounters			X					X									X		
D3 Alternate Clearances			X					X											
E Encounter Alert				X							X								
E1 Advanced Alert				X															
E2 Aural/Visual Alarm			X																
E3 User Alert			X																
F Determine Aircraft Action						X						X						X	
G Display Action							X							X					
H Continuous Service							X							X					X

An arriving aircraft being tracked by the Approach or En Route Controller has been sequenced with other arriving aircraft for landing at a particular airport. Using the aircraft's altitude encoding altimeter, the ACCC detects that the aircraft has descended below its assigned altitude and is soon to be in close proximity to the ground (1). The ACCC predicts that with the aircraft's present flight path and altitude, the aircraft will encounter the ground (2). The ACCC, through the Sector Suite, alerts the Approach/Departure or En Route Controller that the aircraft is in close proximity to the ground (5) and simultaneously determines avoidance action to avoid the encounter (3), issues him a set of actions to avoid the predicted encounter (4). The ACCC relays the avoidance instruction through data communications at the same time the Approach/Departure or En Route Controller immediately issues a safety advisory to the aircraft including the safe altitude for the area that it is in and the corrective actions to be taken (6). The aircraft executes the recommended maneuver and avoids encountering the ground (7).

2.5.2 Tower Operational Sequence

Figure 2-7 depicts the ground and obstacle avoidance assistance provided to pilots by the Local Controller.

While monitoring an approach to the airport on DBRITE, the Local Controller is alerted that the aircraft is descending below the established glide slope (1). The TCCC predicts that the aircraft will encounter the ground (2) and alerts the controller (5). The TCCC determines the proper action to take to avoid the encounter (3) and simultaneously displays the action to the controller (4). The Local Controller immediately issues the maneuver instruction to the pilot (6) who initiates the action and avoids the encounter (7).

In the next sequence, shown in Figure 2-8, the pilot requests his clearance from the Clearance Delivery Controller (1). The Clearance Delivery Controller obtains the proposed flight plan (2). from the flight plan data base (3). and reviews it. This controller discovers that the aircraft has requested an altitude which is too low for a short segment of its intended route of flight (4). and the controller issues the correct altitude to ensure MOCA/MEA clearance within his jurisdiction (5). The pilot is then issued his clearance with the correct altitude (6).

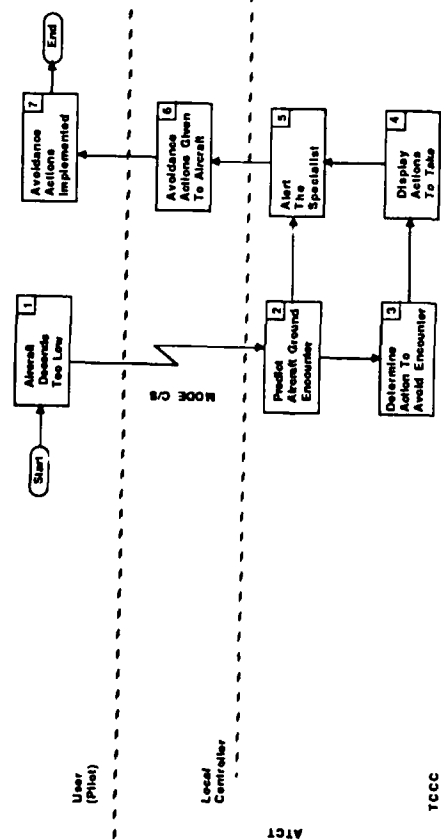


FIGURE 2-7
 LOCAL CONTROLLER
 TOWER OPERATION SEQUENCE DIAGRAM
 FOR GROUND & OBSTACLE AVOIDANCE

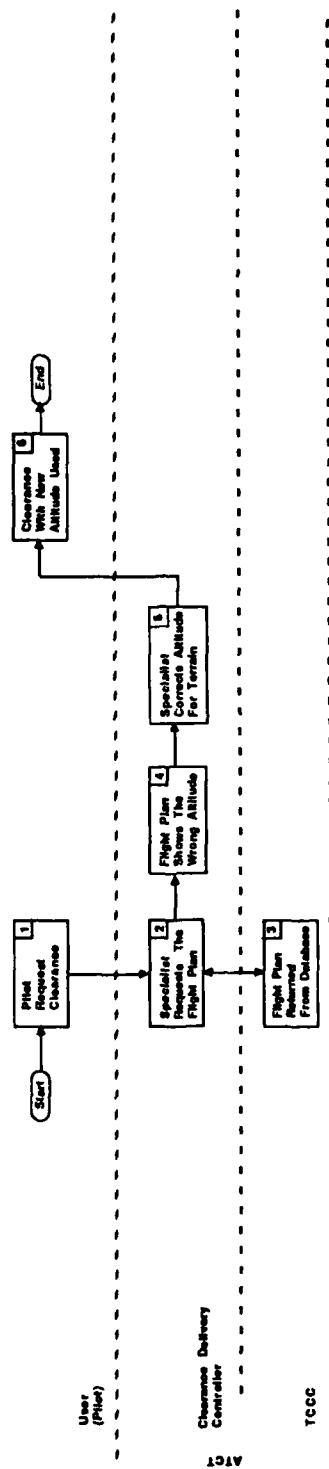


FIGURE 2-8
CLEARANCE DELIVERY CONTROLLER
TERMINAL OPERATION SEQUENCE DIAGRAM
FOR GROUND & OBSTACLE AVOIDANCE

2.6 Operational Scenario

2.6.1 VFR Operational Scenario

In Figure 2-9, N12468, a Piper Cheyenne, is on a VFR flight plan at 4500 ft. and is being tracked by En Route Controllers from the Washington ACF. The pilot of Piper N12468 has requested Minimum Safe Altitude Warning (MSAW) service from the Washington ACF (1) since his route of flight will take him through mountainous terrain (2). Piper N12468 decides to fly between two mountain peaks but does not change his altitude. Due to Piper N12468's low altitude for the surrounding terrain (3), the En Route Minimum Safe Altitude Warning (E-MSAW) activates through the ACCC (4) and alerts the En Route Controller (5/6). This controller will immediately alert Piper N12468 with a low altitude alert (7), advise him to check his altitude (8), and inform him of the MEA/MOCA for his area (9).

2.6.2 IFR Operational Scenario

In the scenario shown in Figure 2-10, N2025T, a Beech King Air, is being vectored for an Instrument Landing System (ILS) approach. The pilot of N2025T spots a flock of birds ahead and slightly above his altitude. The pilot descends to get below the birds (1) when the MSAW (2) alerts the approach controller that N2025T has gone below the prescribed altitude (3/4). The Approach Controller immediately issues a low altitude alert (5), advises N2025T to check his altitude (6), and issues the appropriate altitude (7). After safely clearing the birds, the pilot climbs back up to the recommended altitude (8).

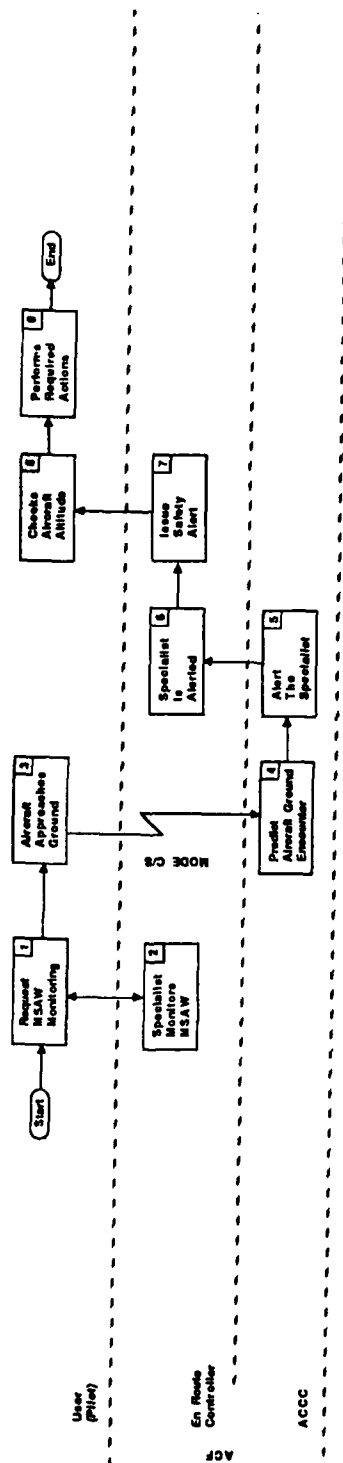


FIGURE 2-9
VFR OPERATIONAL SCENARIO
FOR GROUND & OBSTACLE AVOIDANCE

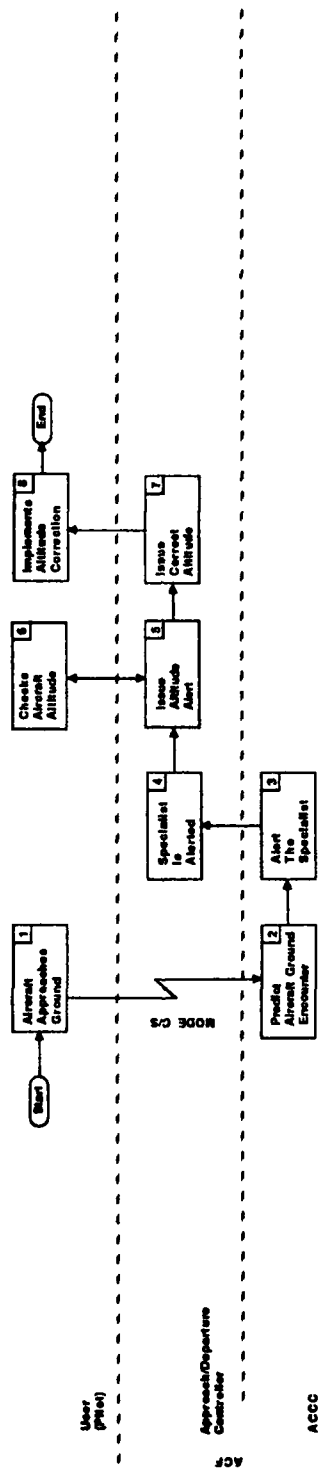


FIGURE 2-10
IFR OPERATIONAL SCENARIO
FOR GROUND & OBSTACLE AVOIDANCE

2.6.3 Tower Operational Scenario

Figure 2-11 describes a similar scenario where N222MM, a MU-2, is making an instrument approach. The pilot of N222MM reports the outer marker in-bound and the Local Controller, looking at the DBRITE, observes the aircraft, checks for traffic, then issues a clearance to land.

N222MM descends below the prescribed altitude for this approach (1). The TCCC predicts an encounter with the ground (2). The Local Controller is alerted through the DBRITE from the TCCC that N222MM is too low (5). At the same time the TCCC determines the proper action to avoid the ground (3) and simultaneously presents the proper action to the controller (4). The Local Controller immediately issues the avoidance maneuver to the aircraft (6). The pilot initiates the climb back to the proper altitude (7) and completes the approach safely.

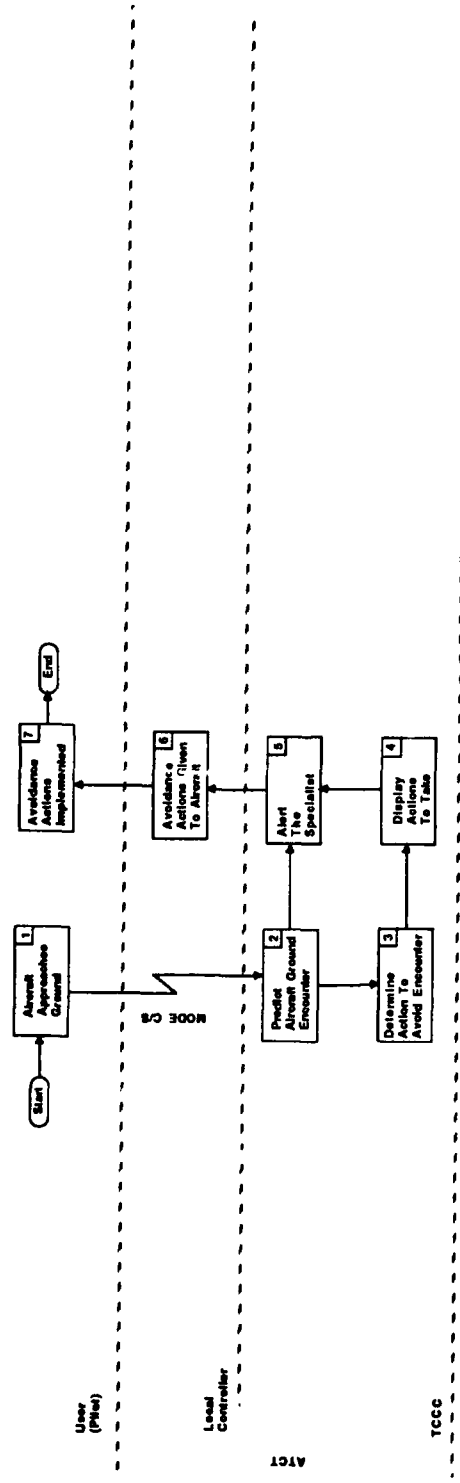


FIGURE 2-11
TOWER OPERATIONAL SCENARIO
FOR GROUND & OBSTACLE AVOIDANCE

REFERENCES

Federal Aviation Administration, Air Traffic Control, 7110.65E, Current edition, Washington, D.C.

Federal Aviation Administration, Airman's Information Manual, Current edition, Washington, D.C.

Federal Aviation Administration (December 1986), National Airspace System Level I Design Document, NAS-DD-1000B, (Includes SCN-1 through SCN-11), Washington, D.C.

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GLOSSARY

ALTITUDE RESTRICTION - An altitude or altitudes, stated in the order flown, which are to be maintained until reaching a specific point or time. Altitude restrictions may be issued by ATC due to traffic, terrain, or other airspace considerations.

DIGITAL BRITE RADAR INDICATOR TOWER EQUIPMENT (DBRITE) - Alphanumeric display systems for control towers using digital scan converter systems in a radar scope-type presentation.

EN ROUTE AIR TRAFFIC CONTROL SERVICES - Air traffic control service provided for aircraft on IFR flight plans, generally by ARTCCs, when these aircraft are operating between departure and destination terminal areas. When equipment capabilities and controller workload permit, certain advisory/assistance services may be provided to VFR aircraft.

EN ROUTE MINIMUM SAFE ALTITUDE WARNING (E-MSAW) - A function of the NAS Stage A en route computer that aids the controller by providing an alert when a tracked aircraft is below, or predicted by the computer to go below, a predetermined minimum IFR altitude.

MINIMUM DESCENT ALTITUDE (MDA) - The lowest altitude, expressed in feet above mean sea level, to which descent is authorized on final approach or during circle-to-land maneuvering in execution of a standard instrument approach procedure where no electronic glide slope is provided. (See Nonprecision Approach Procedure)

MINIMUM EN ROUTE IFR ALTITUDE (MEA) - The lowest published altitude between radio fixes which assures acceptable navigational signal coverage and meets obstacle clearance requirements between those fixes. The MEA prescribed for a federal airway, or segment thereof, area navigation low or high route, or other direct route applies to the entire width of the airway, segment, or route between the radio fixes defining the airway, segment, or route. (Refer to FAR Parts 91 and 95; AIM)

ACRONYMS

ACF	Area Control Facility
AIM	Airman Information Manual
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
DBRITE	Digital Bright Radar Indicator Tower Equipment
E-MSAW	En Route Minimum Safe Altitude Warning
FSDPS	Flight Service Data Processing System
IFR	Instrument Flight Rules
MDA	Minimum Descent Altitude
MEA	Minimum En Route Altitude
MHA	Minimum Holding Altitude
MHZ	One Million Hertz
MIA	Minimum IFR Altitudes
MOCA	Minimum Obstruction Clearance Altitude
MSA	Minimum Safe Altitude
MSAW	Minimum Safe Altitude Warning
MVA	Minimum Vectoring Altitude
NAS	National Airspace System
UHF	Ultra-High Frequency
VFR	Very High Frequency
VHF	Visual Flight Rules